Positron Beam Lifetime Spectroscopy of Atomic Scale Defect Distributions in Bulk and Microscopic Volumes

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We are developing a defect analysis capability based on two positron beam lifetime spectrometers: the first is based on a 3 MeV electrostatic accelerator and the second on our high current linac beam. The high energy beam lifetime spectrometer is operational and positron lifetime analysis is performed with a 3 MeV positron beam on thick sample specimens. It is being used for bulk sample analysis and analysis of samples encapsulated in controlled environments for *in situ* measurements. We have begun development of a second, low energy, microscopically focused, pulsed positron beam for defect analysis by positron lifetime spectroscopy. This instrument will be placed at the high current positron source at the LLNL electron linac which now runs at 10^{10} $e^{+}s^{-1}$. This beam will enable defect specific, 3-dimensional maps of defect concentration with sub-micron location resolution. When operational this instrument will enable new levels of defect concentration mapping and defect identification with the aid of first principles calculations of defect specific positron lifetimes. We will describe elements of the high energy beam and low energy microprobe design and discuss uses of these instruments in studying defect distributions in materials. This work was performed under the auspices of the US Department of Energy by LLNL under contract No. W-7405-ENG-48.